AD NUMBER

AD490088

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AUTHORITY

AMC-FA ltr, 9 Apr 1976

TECHNICAL INFORMATION
REPORT 8-1-1B1(1)

OFFICE, CHIEF OF ORDNANCE
APRIL 1960

"PREPARED FOR THE U.S. ARMY MATERIEL COMMAND BY THE ARMY MATERIEL RESEARCH STAFF, UNIVERSITY OF PITTSBURGH, UNDER CONTRACT DA-36-034-AMC-3785(X)".

DEVELOPMENT OF MECHANICAL TIME SUPERQUICK FUZE, M506 (T176E3)

The M506 (T176E3), which was made standard in June 1957, is a dual-purpose 30-second mechanical time and superquick (MTSQ) impact fuze with arming delay. It is designed to replace the M61A2 MT fuze, which has been used in the M73 120-mm high-explosive (HE) shell. Identical with the M61A2 in timing and setting, the M506 differs from it by having an impact element for SQ action and an M124 (T35E7) delayed-arming booster, which has greater safety than the M21A4 booster of the M61A2 fuze; in addition, the M506 fuze is screwed directly into the projectile by threads on the fuze body instead of the booster being screwed to the projectile and the fuze screwed into the booster.

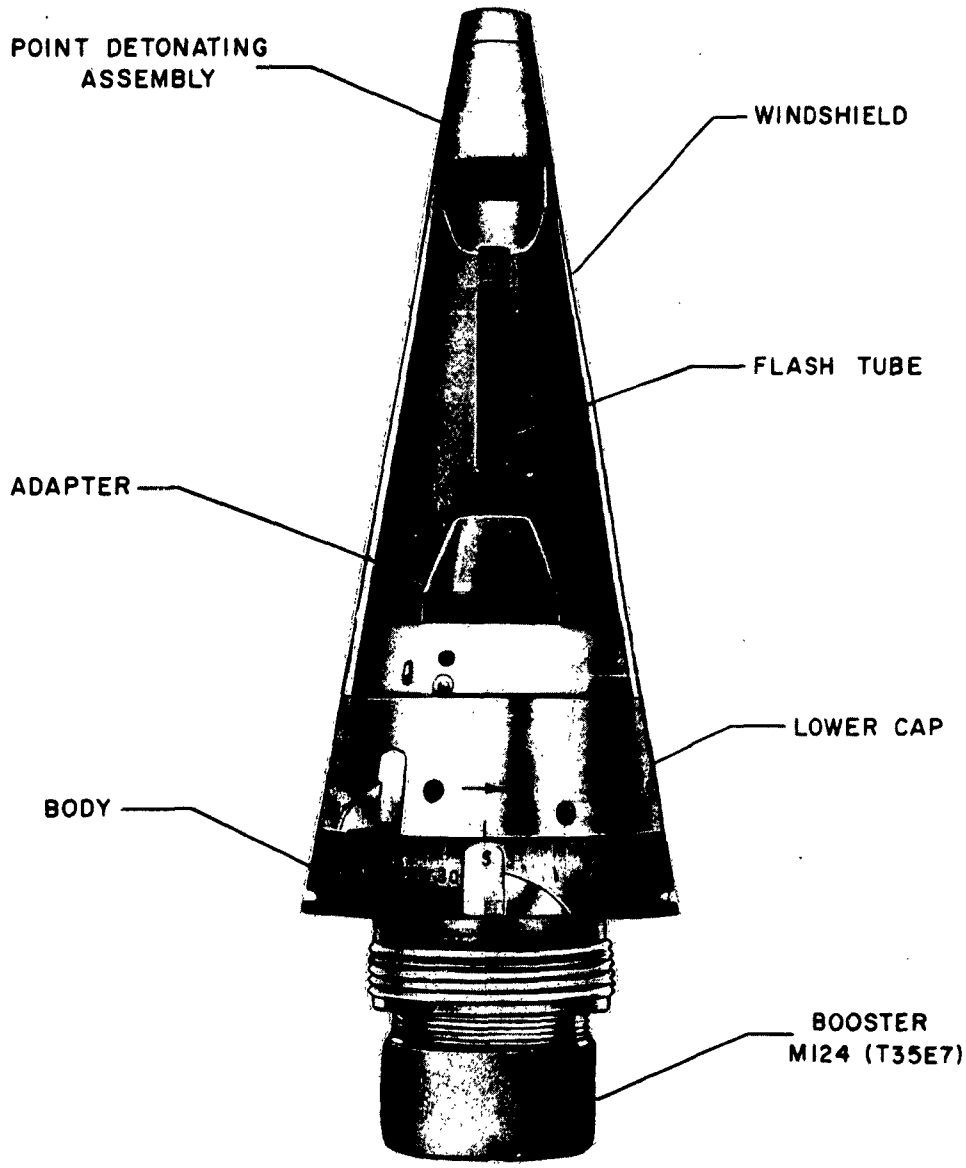
In 1946 a project was started for the development of a combination MT and impact fuze for 120-mm shell to increase the effectiveness of antiaircraft fire. The T176 series of fuzes resulted from this project. The T176 model first developed had an electromagnetic impact element that, after tests in 1950, was reported to lack the sensitivity needed to function on impact with light aircraft (those with skins 0.04 inch thick). The next model, the T176E1, was designed with a Lucky impact element, but it was never produced because it was found feasible to use the simple impact element employed in the M502 MTSQ fuze for 76-mm and 90-mm rounds. The T176E2 fuze with this element made use of the timing movement and other components of the T176E1 fuze.

A small number of T176E2 fuzes, including the M21A4 booster, were tested at Aberdeen Proving Ground (APG) in 1952. In these tests, the fuze performed satisfactorily on ground impact and on impact against light aircraft except at zero obliquity. On the basis of these results, in October 1952 the Ordnance Technical Committee (OTC) approved recommendations that the T176E2 fuze be designated the M506 MTSQ fuze, be adopted as a standard type, and be authorized for use in the M73 120-mm HE shell. At the same time, OTC recommended that the M61A2 MT fuze be reclassified limited standard. Because the T176E2 fuze had been given only limited engineering tests, however, Army Field Forces (AFF), now US Continental Army Command (USCONARC), considered it

RELATED TIR

4-60 TIR 8-1-1(1) Development of Mechanical Time Fuzes for Artillery and Mortars

inadvisable to adopt and procure it in quantity until after complete engineering and service tests had been conducted; consequently, its classification as the M506 MTSQ fuze was disapproved at that time.



CROSS-SECTIONAL VIEW OF MTSQ FUZE, M506 (T176E3)

The T176E2 fuze was then modified to increase the safety of its operation by substituting a T35E7 delayed-arming booster for the M21A4 booster, and the new fuze was designated the T176E3. Tests of a small number of T176E3 fuzes sent to AFF Board Number 4 in early 1954 resulted in an excessive percentage of duds; subsequently, more T176E3 fuzes were produced and fired at APG under conditions duplicating those of service tests. The proving-ground tests, in which a fuze chronograph was used to determine the time of burst, indicated that only 1.25% of the fuzes tested failed to function, whereas the service tests, in which a stop watch had been employed for this purpose, had indicated that 10% were defective. In the belief that the method of checking fuze operation in the earlier tests had produced erroneous readings, Frankford Arsenal stated that the T176E3 MTSQ fuze was considered a satisfactory replacement for the M61A2 MT fuze, and an additional number of the former were prepared for additional service tests. CONARC found the results of the new tests satisfactory and the T176E3 fuze was classified standard in June 1957 as the M506. At that time, development of the T176E4 model was in progress. Work on this model had been started in 1954 to provide better impact action. After the M506 was made standard, however, all further work on the T176E4 was stopped and its development was terminated in November 1957.

The M506 consists essentially of the following main assemblies:

1. A point-detonating assembly, containing an impact firing pin, an arming device comprising two half blocks, and an M23 SQ detonator

2. A windshield to provide a smooth contour between the point-detonating assembly and the rest of the fuze

3. An adapter assembly, containing an M17 auxiliary detonator connected by a flash tube to the SQ detonator

4. A lower cap assembly (containing a setting pin and hammer-spring assembly), which is rotated in relation to the body to set the time

5. A movement, containing a firing pin and timing mechanism to release it

6. The body (containing an M29A1 primer and an M7 relay charge), which is inscribed with a scale to indicate time settings

7. A ball-rotor delayed-arming booster assembly, containing an M19A2 detonator, lead charge, and booster charge

Operation of the timing movement is based on the same principles used in the operation of clocks but centrifugal force instead of a wound spring, acting

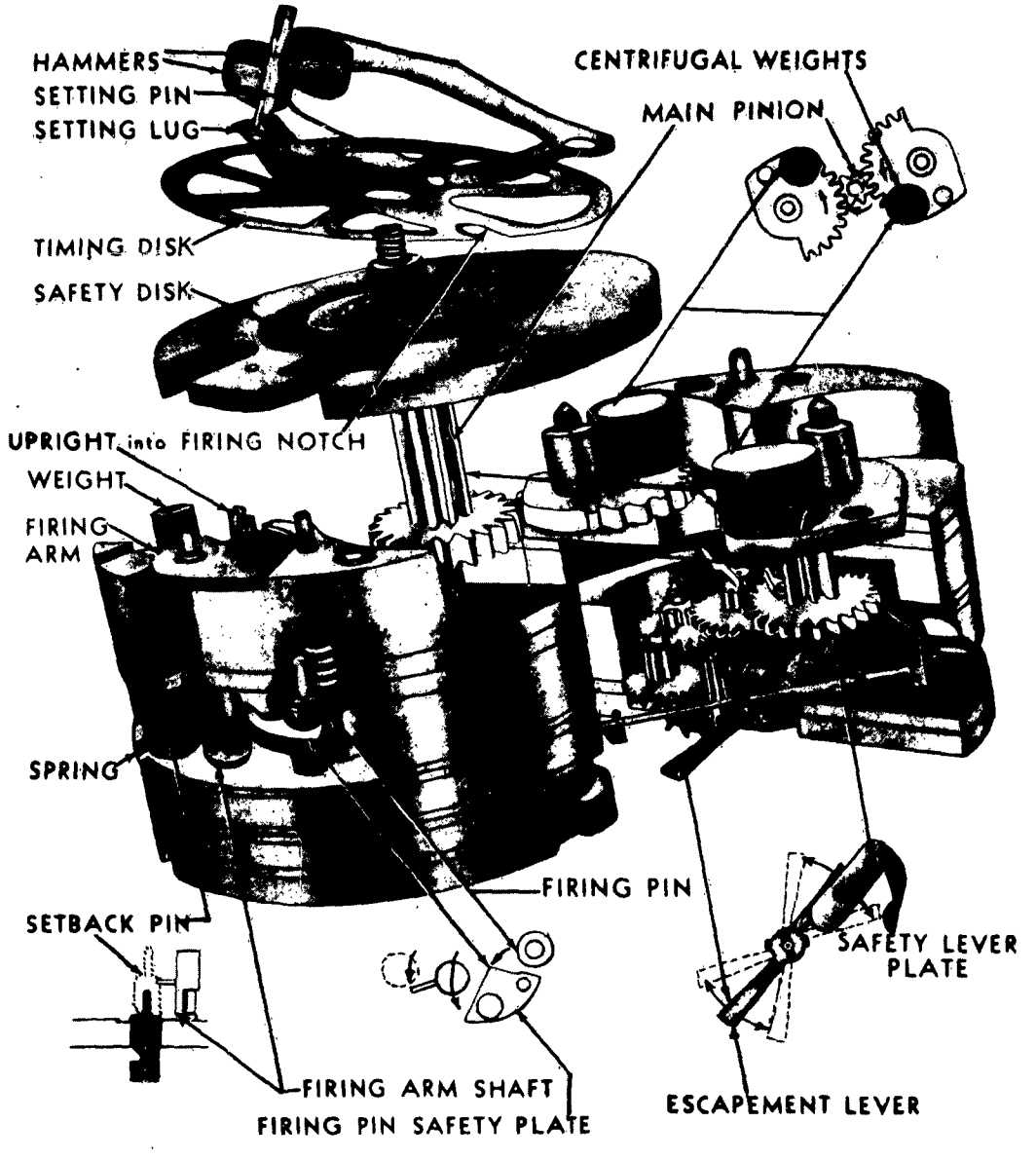
on two weighted gear segments, is the main driving action. Connected to the main gear pinion at the upper end of the mechanism is a timing disk with a protruding forked setting lug and a firing notch. The connection is through a Belleville spring that permits slippage during setting but none when driven by the movement. A centrifugally operated safety-lever assembly locks the entire gear train, including the escapement mechanism, and these parts are not unlocked until the safety-lever plate is swung on its pivot by centrifugal force. This force frees the escapement mechanism and starts the movement. The speed of the movement and the accuracy of the timing are controlled by the escapement, which is adjusted statically before it is adjusted dynamically with the movement assembly prior to assembly with the fuze body. A setback pin locks the firing arm and prevents it from rotating on its pivot until after the setback pin moves to the base of the shell. This movement takes place when the spring that holds the setback pin in position is acted on by setback forces as the setback pin moves rearward, also under setback forces. The firing arm is then free to rotate on its axis and release the firing pin after the timing mechanism has rotated the timing disk sufficiently to bring the firing notch and the firing arm upright into alignment. Prior to the turning of the firing-arm shaft, the firing pin is locked by the firing-pin-safety plate. This plate swings out into a flat on the firing-pin shaft when the shaft is rotated. The firing pin is then driven into the primer in the fuze body under the force of the firing-pin spring. The firing-arm upright cannot move into the groove in the timing disk until, at a predetermined time, it passes a projecting lug on the safety disk, which is mounted directly below the timing disk. This prevents the fuze from functioning if it is set for a dangerously short time.

Safety of the point-detonating element of the fuze is obtained by two half blocks held together by a coiled spring. These are positioned in a recess in the nose to hold the firing pin in the unarmed position. Under centrifugal force, these half blocks move out and free the firing pin, which can then move into the M23 detonator mounted in the nose. The fuze is fired when the projectile hits a target and forces the pin into the detonator.

The M506 is assembled, stored, and transported in the unarmed condition with the mechanical time movement set at the safe position. The safety devices that keep the fuze unarmed include:

1. Half blocks in the point-detonating assembly
2. A safety disk below the timing disk in the movement
3. A safety lever of the escapement in the movement
4. A setback pin in the movement
5. Rotor detents in the booster

No further preparation is required after the fuze has been screwed into the shell if the projectile is to be fired for SQ action only; if time action is desired, the fuze must be set for the selected time by use of a fuze setter or hand-setting wrench. In either circumstance, the fuze remains unarmed until after the projectile has been fired.



TIMING MOVEMENT OF MTSQ FUZE, M506 (T176E3)

The point-detonating assembly becomes armed for SQ impact action when the centrifugal force produced by projectile spin withdraws the half blocks from the impact firing pin, which is then in unobstructed alignment with the SQ detonator. If the fuze has been set for time, setback causes the weights of the hammer-spring assembly in the lower cap to strike and flatten the upraised lug of the timing disk, thereby releasing the disk from its setting pin so that it can be rotated by the main-gear pinion. Setback also causes the setback pin, which up to this moment has locked the firing arm and the safety lever, to move toward the base of the fuze, freeing the firing arm so that it can rotate. Centrifugal force causes the safety lever of the escapement to move outward and unlock the escapement, which thereafter regulates the motion of the gear train; at the same time, centrifugal force puts the weighted gears in motion, and they mesh with the driving pinion of the main gear to set the gear train into operation.

The M124 (T35E7) booster becomes armed only after the projectile has traveled from 75 to 100 feet from the muzzle, the distance depending on the weapon, muzzle velocity, and rate of spin. On firing, centrifugal force withdraws the detents from the ball rotor, which has held the detonator in an out-of-line position. Inertia holds the rotor against its spherical seat until the projectile begins to decelerate, at which time the rotor swings into a position where the detonator is aligned with the other explosive elements. The detonator is held in the armed position by the creep force of the rotor as the projectile continues in flight.

After an M506 fuze has been armed, it will function on impact or at the time set, whichever occurs first. The separate paths that transmit the flash from the impact and time elements join in the body of the fuze to form a single flash path to the delayed–arming booster.

When the nose of the fuze strikes a target, the point-detonating firing pin is driven against the M23 SQ detonator, and the resultant flash, augmented by that of the M17 detonator in the adapter assembly, is transmitted to an M7 relay at the base of the fuze. The fuze will not normally function on graze impact.

Time functioning occurs after the timing disk has rotated to the position at which a notch in it engages the upright projection of the firing arm and permits the firing-arm shaft to rotate, thereby releasing the safety plate from the firing pin. Thereupon, the pin is driven by its spring into the M29A1 primer, and the resultant flash is transmitted to the M7 relay at the base of the fuze.

Because the explosive elements in the booster have been aligned as soon as a projectile has traveled the requisite distance for delayed arming, detonation of the M7 relay by either the impact or the time element fires the M19A2 detonator, lead charge, and main charge of the booster. This sets off the explosive charge in the projectile.

Like other MTSQ fuzes, the M506 may be used as an air-burst fuze to function at the time selected, as a simple impact fuze by leaving the time setting at the safe position, or as a self-destroying impact fuze by setting the timing

movement for a longer period than that required to reach the target.

PRINCIPAL CHARACTERISTICS

Model	M506 (T176E3)
Type	MTSQ
Materials	
Point-detonating assembly	aluminum
Windshield	steel
Lower cap	aluminum
Body	aluminum
Booster	steel and brass
Weight, with booster	2.61 lb
Length	
Over-all	9.52 in
Intrusion	2.21 in
Maximum diameter	3.0 in
Thread size	2-12 NS-1
Time-range setting	
Method	fuze setter or hand wrench
Maximum	30 sec
Minimum	0.8 sec
Setting torque	100 lb-in
Arming	
Distance of arming delay (SQ functioning)	4 ft
Rotation required	1,200 rpm
Acceleration required	7,500 g
Actuation	
Method	time or impact
Minimum time for functioning	0.6 sec
Ballistic data	
Maximum muzzle velocity	3,100 fps
Maximum acceleration	15,500 g
Maximum rotation	16,000 rpm
Firing train	
Detonators	M23, M17
Primer	M29A1
Relay	M7
Booster	
Model	M124 (T35E7)
Weight	0.63 lb
Length	1.88 in
Diameter	1.716 in (max)
Thread size, external	1.7-14 NS-1

Arming	
Distance of arming delay	40-100 ft
Rotation required	4,000 rpm
Explosive train	
Lead charge	3.0 grains of tetryl
Booster charge	350 grains of tetryl
Temperature limits	-40° F and +160° F
Direction of setting	counterclockwise
Projectile with which fuze is used	M73 120-mm HE shell